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Technical Report: NAVTRADEVCEH IH-190

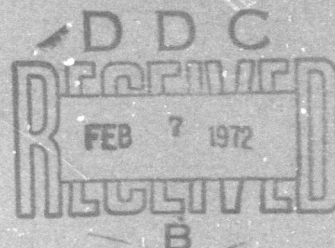
CLOTHING PENETRATION TESTS FOR THE M-16 TRAINING CARTRIDGE

David T. Long
Visual Simulation Laboratory
Task 7883-38

December 1971

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ORLANDO, FLORIDA

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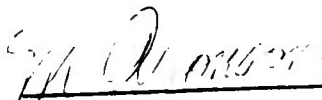
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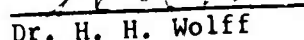
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SECTION I

INTRODUCTION

The Remington Arms Company developed an M-16 non-casualty training cartridge, as required by the Naval Training Device Center Contract N61339-68-C-0141. Ballistic performance information for this cartridge was the purpose of technical report NAVTRADEVCCEN IH-165(1).

No data exists to provide an estimate of safety of the M-16 training cartridge when a trainee is accidentally in its line of fire in a combat village exercise.

This report describes tests and evaluation of this cartridge relative to its injuriousness to trainees.

SECTION II

STATEMENT OF THE PROBLEM

Training projectiles for M-16 rifles have been developed. These bullets are used in conjunction with pop-up targets and were designed to permit training under combat village conditions.

Though it is not intended that these bullets be directed toward trainees one may accidentally strike an individual. This being so, it is necessary to determine if adequate protection is provided trainees by standard military clothing and possible special protectors, such as face shields. For purposes of this report, adequate protectors are defined as those protectors which prohibit penetration by training bullets.

SECTION III

PROCEDURE

INTRODUCTION

To answer the question, "Should one of the M-16 training bullets strike a protected area of a trainee, would he be injured?", many factors were considered. Finally, however, a decision was made to simulate a trainee wearing the minimum protective articles, expected in a training situation where these bullets are being used. Tests then would be made to determine if the bullets are capable of penetrating the protective articles.

TRAINEE SIMULATION

Bundles of Nu-wood insulation material were used to simulate "naked" trainees. Each of these bundles consisted of 24 tightly bound pieces, each having the dimensions 60 in. L x 12 in. W x 1/2 in. T. Standard

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protective articles consisting of a fatigue jacket, a pair of combat boots, an armor jacket and a field jacket were used as test articles.*

DESCRIPTION OF REMINGTON CARTRIDGE

The loaded cartridge weighs 103 grains and contains a 92M standard military primer and one grain of EX8220 gun powder. The projectile is a hollow gilded material cup, closed at the heel, open at the nose and weighs approximately 4.71 grains. The projectile has a range of about 200 feet, an average velocity of 606 ft/sec and the average kinetic energy of 3.8 ft-lb at a distance of 100 ft from the rifle muzzle. See reference (1).

TEST PREPARATIONS

Preparations for the tests consisted of carrying to the range the following:

- a. Articles to be tested (fatigue jackets, boots, armor jackets and field jackets).
- b. Two M-16 rifles.
- c. M-16 non-casualty training cartridge (size, 5.56m; weight 4.71 grains).
- d. M-16 ball ammunition.
- e. Bundles of Nu-wood.
- f. Variable-velocity BB gun.
- g. BB gun pellets (size, 4.45mm; weight, 5.43 grains).
- h. Velocity measuring equipment (Models 601 and 6100 Ballistic Photoelectric Screens and Model 4000 Velocity Computing Chronograph, all manufactured by Electronic Counters, Inc.).

*1st LT T. B. Trammel, USMC, Marine Liaison Officer, Naval Medical Field Research Laboratory, Camp Lejeune, N.C. performed tests on two types of face shields, using the M-16 training cartridge. These shields are identified as: (1) Army Flier's Type FSN 8415-933-9282; and (2) Riot Control from American Optical Company Stock No. AO X 3320. Both shields were obtained from the Medical Field Research Laboratory, and were found to provide adequate protection. Both shields stopped all rounds at a range of three feet. The Army type, however, contained deep dents after the tests; the Riot Control Type was virtually unmarked.

In view of these tests, the tests at the Naval Training Device Center were limited to standard protective clothing.

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At the range, the rifles and BB gun were rigidly mounted; the Nu-wood bundles were positioned down-range at a distance of 100 ft from the gun muzzles; the test articles were either "draped over" or placed in front of the Nu-wood bundles; and the velocity screens were properly positioned in the line of fire. (Note: "Properly positioned" means that one screen was located 75 ft from the gun muzzles and the other screen at 95 ft). Incidentally, the overall accuracy of the complete velocity measuring system is ± 7 ft/sec.

The M-16 rifles were prepared for the tests by firing a few rounds of ball ammunition. This was the practice, as required, prior to each test.

TEST CONDITIONS

The tests were conducted under moderate temperatures of 70°F to 90°F with no significant cross wind (less than 5 mph).

TESTS

The tests were designed to determine (1) if at 100 ft from the gun muzzle the level of kinetic energy of the M-16 non-casualty training bullet is sufficient to penetrate the articles being tested; and (2) at what kinetic energy level penetration occurs.

ACCOMPLISHING FIRST REQUISITE

To accomplish the first of these requisites, it was necessary to fire several rounds of the M-16 cartridges through the velocity screens, through the protective articles (if possible) and into the Nu-wood bundles. (Note: The velocity data obtained with the screens was used in accomplishing the second requisite. See below).

ACCOMPLISHING THE SECOND REQUISITE

To accomplish the second of these requisites, two steps were taken. In the first step, the variable-velocity BB gun was adjusted to "high velocity". It was then used to fire several pellets, under the same circumstances which were present when the M-16 was fired above. (Note: Initially, it was thought that the penetration thresholds of the training bullet and the BB pellet would be approximately the same; by establishing threshold for the BB, that for the training bullet would become known. The velocity setting of the BB was then reduced and the firing repeated.)

This procedure was continued until the threshold of penetration for each article being tested was determined.

Next, the M-16 data obtained while accomplishing the first requisite were plotted.

SECTION IV

RESULTS

The test data obtained in Section III are presented in table 1 and figures 1 through 5. Observe that, for purposes of comparison, the "threshold of penetration" levels for the BB pellets are shown on figures 3 and 4.

SECTION V

DISCUSSION

Obviously, the shapes and sizes of the M-16 training cartridge and the BB pellet are different. Upon close examination of the two projectiles, however, the total areas that come into contact with the test articles appear to be quite similar. If contact area was the only criteria that related to penetration, one would think that the two projectiles, when endowed with equal kinetic energies, would penetrate a material to approximately the same extent. This did not occur; consistently, the M-16 training bullet penetrated at a lower energy level. See table 1 and figures 3 and 4.

Its shape seems to have a bearing on the penetrating capabilities of the training bullet. In addition, its shape probably causes the bullet to be somewhat unpredictable in its travel toward the target.

Another interesting thing about this cartridge is its wide range of velocities. As may be seen in table 1 and figures 3 and 4, at a 100 ft range, these extend from about 504 ft/sec to about 674 ft/sec.

SECTION VI

CONCLUSIONS

It may be seen from table 1 and figures 3 and 4 that if the M-16 training bullet is to be considered safe at a distance of 100 ft from the rifle muzzle, then its velocity must not exceed about 550 ft/sec. This contrasts with 575 ft/sec for the BB pellets.

SECTION VII

RECOMMENDATIONS

If the bullet from an M-16 training cartridge is to be considered non-injurious to the normally protected trainee, then it is recommended that the velocity of the bullet at a distance of 100 ft from the rifle muzzle not be allowed to exceed 550 ft/sec.

It is further recommended that the training bullet be investigated from the standpoint of possibly changing its shape. The first step in

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this investigation would be to close the leading edge of the bullet. From this point of departure, other shapes of the leading edge should be tried. These would range from a rounded to a blunt nose.

REFERENCES

1. Long, David T.: Ballistic Tests on the M-16 Training Cartridge, Technical Report: NAVTRADEVGEN IH-165, Naval Training Device Center, June 1969.

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Table 1. RESULTS OF BB PELLETS AND M-16 TRAINING CARTRIDGES
STRIKING SINGLE LAYER PART OF COMBAT BOOT

Combat Boots						
BB Pellets				M-16 Training Cartridge		
Kinetic Energy ft.lb.	Velocity ft/sec	Effect on Boot		Kinetic Energy ft.lb.	Velocity ft/sec	Effect on Boot
7.30	776.5	Penetration	Threshold of penetration			Penetration
6.97	759.0	"				
5.75	689.3	"				
5.60	679.6	"				
5.57	678.4	"				
5.55	677.2	"				
5.25	657.8	"				
5.14	651.0	"				
5.06	647.0	"				
4.95	639.0	No Penetration				
4.94	638.8	"				
4.93	638.1	"				
4.90	636.0	"				
4.66	620.6	"				
4.34	599.9	"				
4.30	596.5	"				
4.27	593.8	"				
4.28	595.2	"				
4.26	593.8	"				
3.95	571.1	"		4.20	632.8	Penetration
3.82	561.0	"		3.65	490.4	No Penetration
3.45	534.1	"		3.57	541.7	"
3.08	504.1	"		3.28	560.1	"
3.04	501.8	"				
3.00	497.7	"				
1.19	313.1	"		2.87	523.9	"

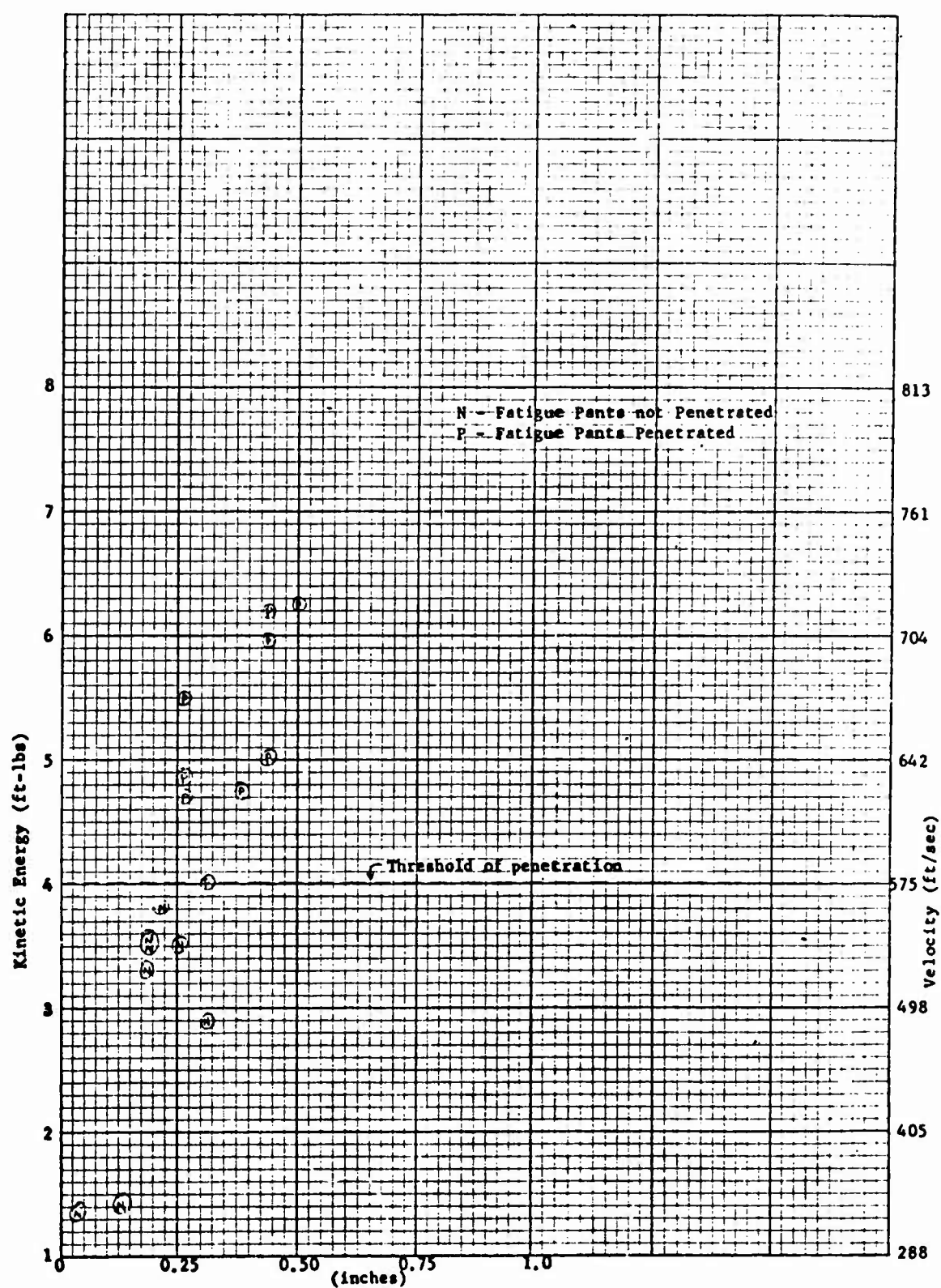


Figure 1. Penetration into Nu-Wood by BB Pellets After Striking Fatigue Jacket

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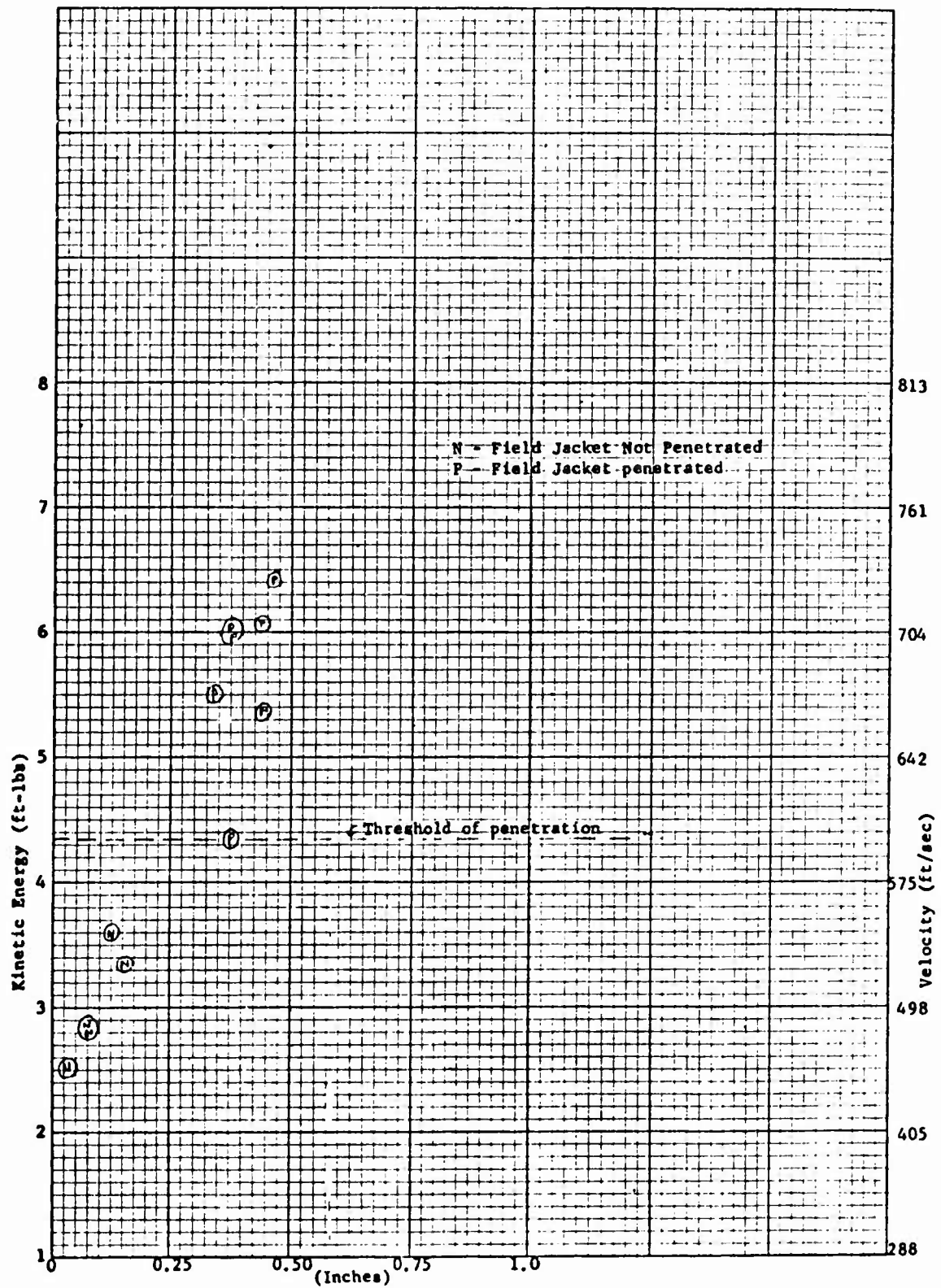


Figure 2. Penetration into Nu-Wood by BB Pellets After Striking Field Jacket

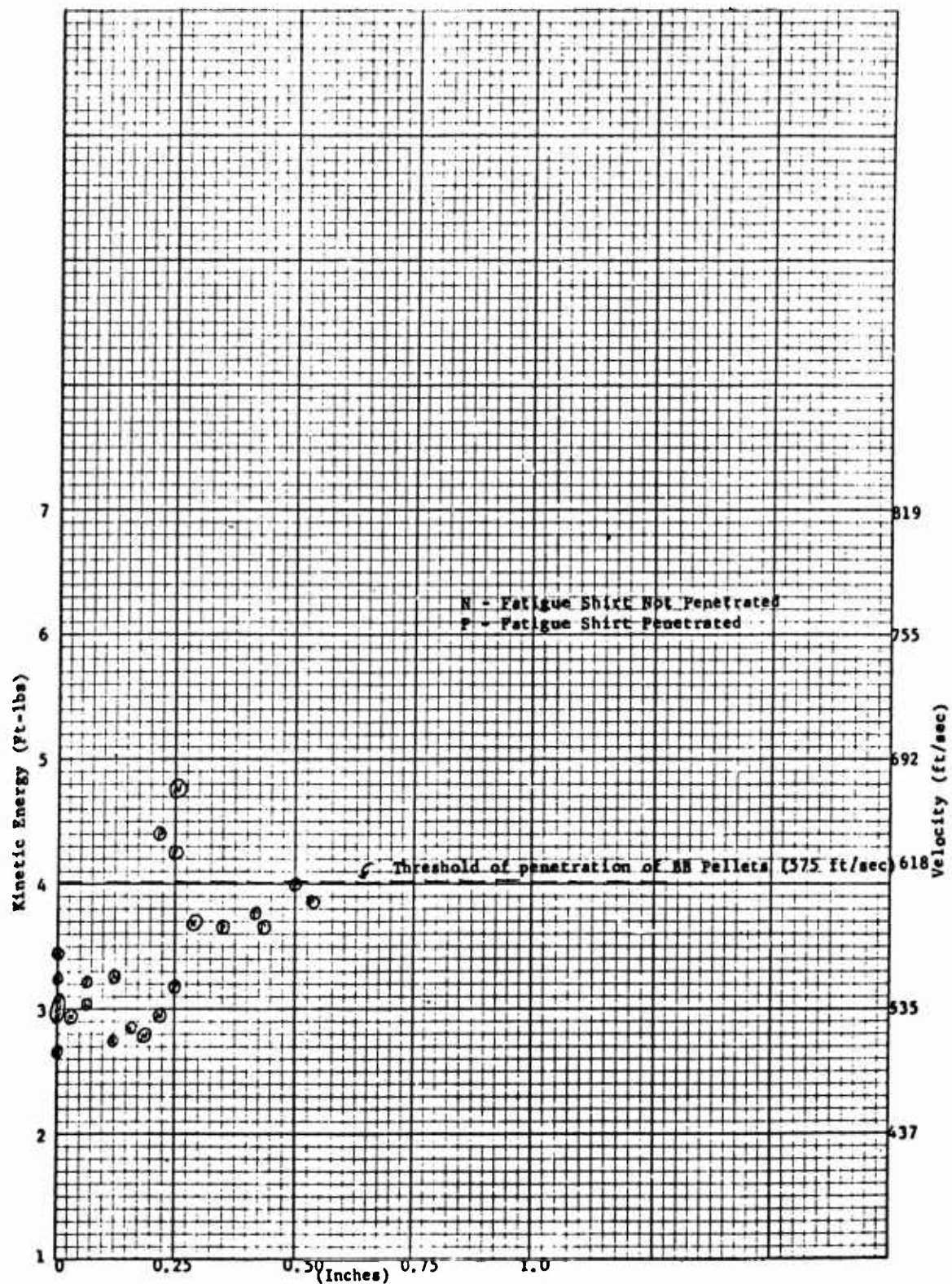


Figure 3. Penetration into Nu-Wood by Bullets of M-16 Training Cartridges After Striking Fatigue Jacket

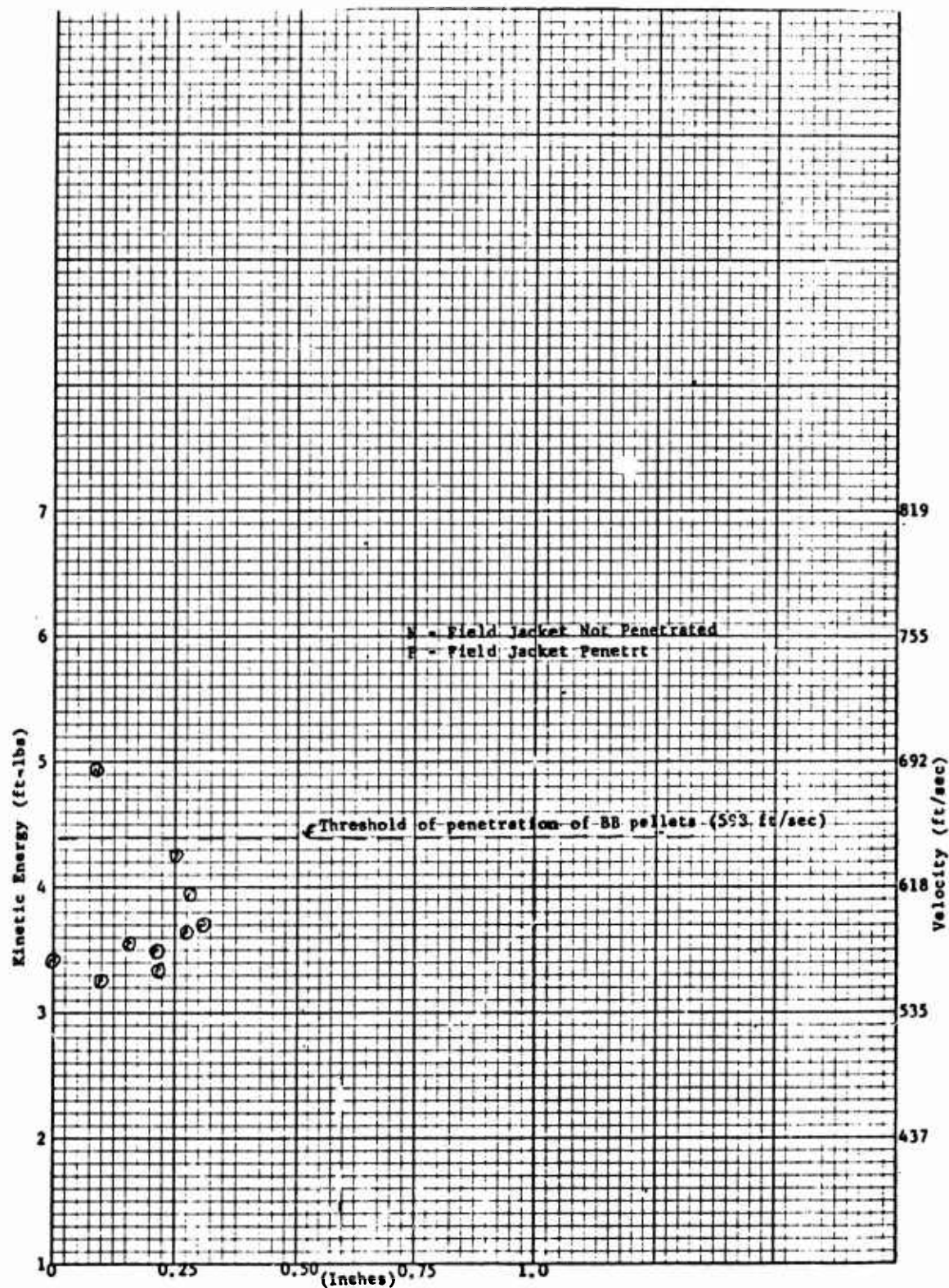
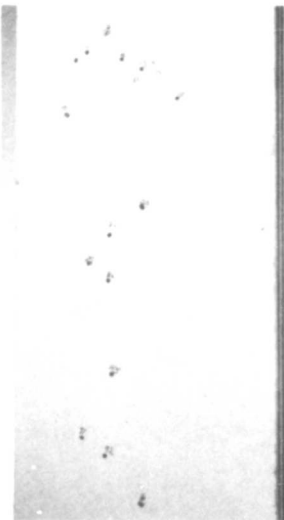


Figure 4. Penetration into Nu-Wood by Bullets of M-16 Training Cartridges After Striking Field Jacket

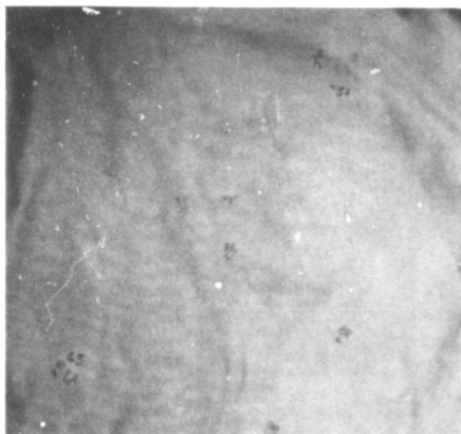


A. Nu-wood Panel

NOT REPRODUCIBLE



B. Fatigue Shirt



C. Field Jacket



D. Combat Boots

Figure 5. Test Materials Showing Penetration Results of M-16 Training Bullets